

Exposure of American robins (*Turdus migratorius*) to PCDF and PCDD on the Tittabawassee River floodplain, MI, USA.

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ABSTRACT

Polychlorinated dibenzofuran (PCDF) and polychlorinated dibenzo-*p*-dioxin (PCDD) concentrations in the tissues of receptor species are important assessment endpoints in evaluations of ecological risk. During the spring and summer of 2005, 2006 and 2007, 67 American robin eggs, 30 nestlings and 12 adults were collected from the Tittabawassee River floodplain from upstream reference sites and study sites downstream of the city of Midland, MI, USA. Previous studies have indicated that study sites had concentrations of PCDF and PCDD that were greater than in nearby reference areas. Concentrations of the 17 2,3,7,8 substituted PCDFs and PCDDs were quantified in American robin tissues and normalized to 2,3,7,8 dibenzo-*p*-dioxin using WHO avian 1998 TEQs. Preliminary American robin egg TEQs ranged from 2.4 ng/kg ww to 1.5 x 10³ ng/kg ww in reference areas and 2.5 x 10³ ng/kg ww to 1.7 x 10³ ng/kg ww in study areas, while preliminary nestling tissue TEQs ranged from 1.0 ng/kg ww to 2.1 x 10³ ng/kg ww in reference areas, and 4.7 x 10³ ng/kg ww to 5.6 x 10³ ng/kg ww in study areas.

INTRODUCTION

The American robin (*Turdus migratorius*) is a useful receptor for the ecological risk assessment of study areas contaminated with bioaccumulative contaminants of concern (COCs) (Hemming *et al.*, 2003). American robins have an intimate relationship with soil as a nest building material and soil ingesting invertebrates as dietary components, including earthworms. Robins are common and nesting distribution is widespread, making data collection and sampling realistic. The American robin is an ideal representative passerine study species exposed to the soil-to-invertebrate food web in the area of concern.

METHODS AND MATERIALS

- American robin tissues were collected in 2005, 2006, 2007 and 2008 from nests located within the floodplains of target and reference areas of the Tittabawassee River floodplain
- Fresh egg samples were collected randomly prior to or during incubation
- Added egg samples were collected opportunistically following hatch date or nest failure
- Egg sample TEQ concentrations based on calculated fresh mass minus the mass of shell (Hoyt, 1978)
- Nestling samples were collected approximately 12 d following hatch date
- Nestling samples homogenized following removal of feathers, bill and legs below the tibiotarsus
- Soil samples and dietary samples collected from the Tittabawassee River floodplain 2003-2006
- Concentrations of TEQ in soil are expressed as ng/kg on a dry weight basis and ng/kg wet weight for tissues
- Chemical extraction EPA methods 3540C and 3541
- Analyses of the 17 2,3,7,8 substituted PCDF/D congener concentrations in samples are conducted atASUREQuality Limited (Lower Hutt, New Zealand) using EPA method 8290
- All TEQ values based on avian World Health Organization toxicity equivalency factors (Van den Berg *et al.*, 1998)
- The TEQ concentrations are calculated by assigning a proxy value of 1/2 the detection limit (DL) for congeners below the DL.

Study area median nestling TEQs more than 40 times greater than reference area

Figure 1. Map of sampling locations in the Tittabawassee River floodplain in Michigan, USA.

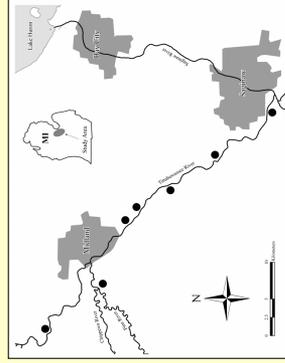


Table 2. Concentrations of TEQo-avian (ng/kg dw) measured in surface soil of the Tittabawassee River floodplain.

	Reference	Study
N	11	27
Median	6.7	4478
Min	3.95	425
Max	24.8	18800

Table 3. Concentrations of TEQo-avian (ng/kg ww) in American robin egg and nestlings collected in the Tittabawassee River floodplain.

	Reference Area		Study Area	
	Median	95% UCL (n)	Median	95% UCL (n)
Egg	7.2	9.2 (16)	183	391 (37)
Nestling	3.6	9.7 (8)	157	253 (14)

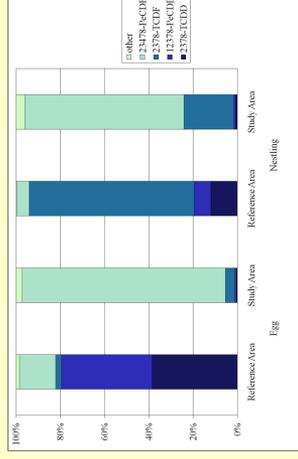
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Table 1. Concentrations of TEQo-avian (ng/kg ww) measured in diet items of the Tittabawassee River and composition.

Dietary Item	Ref.		Study	
	median	max	median	max
Plant	0.6	1.8	2.7	13
Coleoptera	3.3	16	410	1900
Lepidoptera	1.0	1.5	42	98
Misc.	1.2	4.5	23	380
Earthworm	1.4	2.4	220	530

Figure 2. Congener contribution of avian TEQs for American robin tissues in the Tittabawassee River floodplain.



RESULTS

TEQ concentrations in dietary items are greater in study areas than in reference areas. Median TEQ concentrations in reference areas are as great as 3.3 ng/kg ww while study area median TEQ concentrations are as great as 4.1 x 10³ ng/kg ww in the same taxonomic order, Coleoptera, or beetles (Table 1). TEQ concentrations in soil are greater in study areas than in reference areas. Concentrations measured in reference area soils are as little as 4.0 ng/kg dw while study location soils exhibit concentrations as great as 1.9 x 10⁴ ng/kg ww (Table 2). Conger profiles vary between reference and study areas with 2,3,4,7,8-PeCDF contributing approximately 80% to the total TEQs in eggs and 70% in nestlings in study areas, whereas 2,3,4,7,8-PeCDF contributes less than 20% to the total TEQs in eggs and less than 10% in nestlings in reference areas (Figure 2). Median TEQ concentrations in American robin tissues are greater in study areas than in reference areas. Median TEQs are as little as 3.6 ng/kg ww in reference nestlings and as great as 1.8 x 10³ ng/kg ww in study area eggs (Table 3).

CONCLUSIONS

- Median soil TEQ concentrations are more than 600 times greater in study locations than in reference locations.
- Median invertebrate dietary item TEQ concentrations are more than 1 order of magnitude greater in study areas than in reference areas.
- 2,3,4,7,8-PeCDF predominates the congener profiles of both eggs and nestlings collected from the study area.
- 1,2,3,7,8-PeCDD and 2,3,7,8-TCDD account for the greatest percentage of reference egg congener profiles while reference nestling profiles are predominately 2,3,7,8-TCDF.
- Median American robin egg TEQ concentrations are more than 25 times greater in study locations than in reference locations.
- Median American robin nestling TEQ concentrations are more than 40 times greater in study locations than in reference locations.
- American robin tissue TEQ concentrations comparable to those in tree swallow (*Tachycineta bicolor*) tissues where hatching success was negatively associated with concentrations of 2,3,7,8-TCDD in eggs in of the Woonasquatucket River, Rhode Island, USA.

REFERENCES

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2,3,4,7,8-PeCDF accounts for greater than 70% of the total TEQs in study area American robin tissues